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Standardization of hake LPUE series of the Galician set-longline fleet in Subarea VII

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ABSTRACT

WGHMM (now WGBIE) identified a problem in the assessment of northern hake in relation to the scarce information on the abundance of large fish. 2004 WKSOUTH tested the inclusion in SS3 of Galician LPUEs from set-longline fleet targeting hake in ICES Subarea VII. This metier catches mainly adults. However, during WGBIE 2014, a serious inconsistency was detected when updating this LPUE time series, related to the assumption of the average fishing days by trip employed along the time series. The current working document provides the revision of this LPUE series by applying the actual number of fishing days by trip recorded in logbooks, which has varied greatly in the final part of the time series. The revised LPUE indices obtained were then tested in the assessment of northern hake stock. The difference in results between the assessments without LLPUE and the assessment which includes the new LPUE series were minor. In the initial part of the time series the LPUE matched the abundance closely but in the last period the increase in the LLPUE was much lower than the increase in the stock abundance.

INTRODUCTION

During the WKSOUTH benchmark (ICES, 2014a), some problems identified in the assessment of northern hake by WGHMM (ICES, 2013) were tried to be solved. One of them made reference to the little information on abundance of large fish in the setting of the SS3 model. Therefore, a new LPUE series was provided for the Galician longline fleets targeting northern hake in ICES Subarea VII (Castro *et al*., 2014).

This LPUE series was tested in the northern hake assessment; however it was considered that a deeper analysis of its suitability was necessary in order to use it as an abundance index (ICES, 2013). Therefore, this LPUE series was updated including 2014 value to be tested by WGBIE 2014 (ICES, 2014b). However, the 2014 effort altered the LPUE trend provided two months after. This was due to the 2014 value was based on real effort registered in logbooks, while the previous series have been compiled from sales notes, applying a mean factor of fishing days by trip. Therefore, the series could not be completed to be tested by WGBIE 2014.

During 2015, an effort was made to analyze the longest time series of logbooks available, in order to detect any possible change in fishing strategy to explain the observed change in trend. This paper describes the work developed, presents the new standardized LPUE series and also provides the SS3 results obtained by including this index in the northern hake assessment.

MATERIAL AND METHODS

On one hand, landings and length frequency distributions (LFD) form the LPUE series presented at WKSOUTH were updated with 2014 and 2015 data. On the other hand, all the time series of effort was revised by analyzing the available series of Spanish logbooks, form 2003 to 2015. These analyses permitted to calculate the mean number of fishing days by trip and year, in order to detect any possible change in the fishing strategy of the Galician longline fleet operating in Subarea VII.

Regarding the northern hake assessment, this was done by applying the SS3 model (Methot and Wetzel, 2013), as well as the current setting accepted by WGBIE (ICES, 2015).

RESULTS

Standardization of the LPUE series

The Galician set longline fleet is compounded by Spanish vessels landing in the three most important ports in Northern Galicia: A Coruña (CIO), Burela (BRL) and Celeiro (CIO). This fleet performs a homogeneous fishing strategy targeting hake in Subarea VII (72% of total effort in 2015) and Division VIIIabd (28%), very rarely accessing the Subarea VI (Figure 1). Individually, Celeiro has been the most important port in landed trips at the beginning of the series, until 2001 when they descend to the level of Burela (Figure 2). A Coruña, similar in effort to Burela at the beginning of the series, descends drastically in 1998, maintaining minimum levels since then.

Regarding the data collection, the most important contribution of this paper with respect to the WD presented at WKSOUTH 2014 is the revision of the number of fishing days per trip and its evolution throughout the time series. The old series provided to WKSOUTH 2014 was based on trips recorded in sales notes, so they were transformed into fishing days by applying a factor that was assumed constant throughout the time series, i.e. 12 fishing days by trip. To calculate the actual number of fishing days that makes up a trip, the longest logbooks series available (from 2003 to 2015) was compiled to be analyzed. The study was enclosed to the effort exerted only in Subarea VII, to avoid the effect of the trips from Divisions VIIIabd which may be shorter.

The results showed that the duration of the trips was varying through the time series. Indeed, trips lasted over 12 days at the beginning of the series, but since 2009 they began to shorten. Therefore, the average of fishing days by trip of years 2003 to 2008 (13.1 fd/trip) was applied to years without logbooks: 1995-2002. The actual fishing days recorded in logbooks were used in the rest of the time series: 2003-2015. Figure 3 shows the evolution in time of total fishing days and the average of fishing days by trip for the studied fleet. After holding steady around 13 fd/trip, in year 2009 effort begins a downward trend to reach 5.8 fd/trip in 2012. Since then, the Galician set-longline trips from Subarea VII show a slight upward trend, reaching 7.1 fd/trip in 2015.

The revised series of fishing days by year provide a new LPUE series very different from that presented at WKSOUTH in 2014. LPUE values are lower than a tonne per fishing day during the years 1995-2008 (mean= 0.74 t/fd). In 2009, the LPUE values start to rise quickly to reach more than 2 t/fd in 2011 and get 2.77 t/fd in 2015.

Testing the LPUE series in the assessment

The revised LPUE series of Galician set-longline fleet operating in Subarea VII was tested in the northern hake assessment. This stock is assessed by using the SS3 method (Methot and Wetzel, 2013), a statistical length-structured population modelling framework highly scalable from data-weak situations where it operates as biomass production model, to complex situations where it can flexibly incorporate multiple data sources and account for biological and environmental processes.

Observed versus fitted values are shown in Figure 5. The fit in the initial part of the time series is fairly good but since 2007 the model overestimates the observed values for all years and quarters. The increase in the longline LPUE was not as high as the increase in the stock abundance. However, Pearson residuals of their length frequency distributions show a "fairly random" behaviour with no particular trend or lack of fit (Figure 6, where blue and red circles denote positive and negative residuals, respectively).

The assessment results show two peaks of recruitment at the end of the time series, in 2008 and 2012 (Table 2; Figure 7). SSB begins to increase drastically from 2009, reaching a six-fold increase in 2015 the average for the period 1978-2008. F, meanwhile, reaches in 2015 the lowest value of the time series (0.2).

The run resulted from incorporating the revised LPUE series (update_lls) was compared with the "updated" run, consisted of including year 2015 to the same setting used in last assessment (ICES, 2015). Both retrospective plots show that for F and SSB the model results are sensitive to the exclusion of recent data, which provoke a revision upwards of SSB and downwards of F (Figures 8 and 9).

DISCUSSION AND CONCLUSIONS

It is known the importance of standardization of effort in a longline LPUE, which is strongly dependent of the number of hooks used by trip. As it was explained in WKSOUTH (ICES, 2014), this information has never been collected, however interviews with skippers describe the gear used by this fleet (number of hooks, type of bite and number sets) to be regular throughout the period recovered here (Castro *et al.*, 2011). On the other hand, the practical lack of discards observed in this logline fleet (Pérez *et al*., 1996) makes reasonable to use landings (LPUE) as proxy of catches (CPUE).

Now that the series has been corrected for the actual fishing days, the commercial CPUE obtained perfectly correlate with the CPUE observed by sampling. The new CPUE series of Galician set-longline in Subarea VII becomes an index that can help better understand the state of the northern hake stock. Its inclusion in the northern hake analytical assessment does not alters the picture provided by the current setting. On the one hand, not significantly change the estimates of SSB or F, and on the other, does not improve the uncertainty of the retrospective pattern in the last years of the time series. Therefore, although this CPUE series is not finally included in the annual northern hake assessment, their provision to WGBIE will expand the knowledge of the evolution of this fishery and the exploited stock.

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Table 1. Landings of hake (t), effort (fishing days) and CPUE (t/fd) of the Galician set-longline fleet operating in ICES Subarea VII.

year	landings	fd	CPUE
1995	9988	12393	0.8
1996	11343	13126	0.9
1997	7303	10349	0.7
1998	4748	9340	0.5
1999	5753	8716	0.7
2000	6262	8345	0.8
2001	6647	8410	0.8
2002	5453	8751	0.6
2003	6092	9591	0.6
2004	7526	9797	0.8
2005	7450	8891	0.8
2006	8268	9613	0.9
2007	9676	11834	0.8
2008	8593	11722	0.7
2009	10319	9013	1.1
2010	17092	9346	1.8
2011	21022	8388	2.5
2012	14294	6766	2.1
2013	10060	4112	2.4
2014	9516	3532	2.7
2015	9521	3441	2.8

Table 2. Summary of landings and assessment results: run including the Galician set-longline LPUE time series.

Year	Rec	B total Jan1	SSB Jan1	Landings (t)	Discards (t)	Catch (t)	Yield/SSB	F (15-80 cm)	Numbers(Pop)
1978	294060	120170	80181	50551	NA	50551	0.6	0.5	644369
1979	274443	129513	101657	51096	NA	51096	0.5	0.5	605707
1980	306993	127734	104212	57265	NA	57265	0.6	0.6	607412
1981	584504	111008	89922	53918	NA	53918	0.6	0.7	882723
1982	407210	102620	73545	54994	NA	54994	0.8	0.7	900813
1983	148430	110214	71870	57507	NA	57507	0.8	0.6	583376
1984	284163	117179	85844	63286	NA	63286	0.7	0.7	544867
1985	667065	101765	81978	56099	NA	56099	0.7	0.8	946313
1986	404086	86396	62222	57092	NA	57092	0.9	0.9	888289
1987	475511	84647	48070	63369	NA	63369	1.3	1.0	889757
1988	516317	84096	50490	64823	2	64825	1.3	1.0	976292
1989	496463	83207	48604	66473	73	66546	1.4	1.1	960164
1990	525607	76016	45206	59954	NA	59954	1.3	1.0	949461
1991	308959	74815	45232	58129	NA	58129	1.3	0.9	727663
1992	318967	76729	45605	56617	NA	56617	1.2	1.0	658488
1993	594914	66618	43525	52144	NA	52144	1.2	1.1	901911
1994	319622	59679	33633	51259	356	51615	1.5	1.1	778153
1995	160716	65574	32612	57621	NA	57621	1.8	1.1	521843
1996	388992	59674	37997	47210	NA	47210	1.2	1.0	590238
1997	268908	50535	32411	42465	NA	42465	1.3	1.1	592805
1998	462014	48332	26442	35060	NA	35060	1.3	1.0	722320
1999	217667	52086	29202	39814	349	40163	1.4	1.0	586769
2000	193578	57868	32120	42026	83	42109	1.3	0.9	449541
2001	342608	57538	38633	36675	NA	36675	1.0	0.8	556943
2002	262948	59682	39260	40107	NA	40107	1.0	0.8	570353
2003	155968	63743	39142	43162	2110	45272	1.1	0.8	433726
2004	324207	65937	44372	46417	2552	48969	1.1	0.8	533181
2005	224119	62007	42901	46550	4676	51226	1.1	0.9	509768
2006	303434	58918	35627	41467	1816	43283	1.2	0.8	554405
2007	478261	66618	42265	45028	2191	47219	1.1	0.7	787801
2008	780376	85494	50953	47739	3248	50987	0.9	0.5	1245349
2009	261940	137616	78373	58818	9871	68689	0.8	0.4	1033596
2010	253802	225878	145666	72799	9415	82214	0.5	0.3	844100
2011	283166	290714	236591	87540	13775	101315	0.4	0.3	775598
2012	603071	298058	257100	85677	12225	97902	0.3	0.3	1059990
2013	433076	303890	254015	77753	11637	89390	0.3	0.3	1114998
2014	265150	339551	267773	89940	6548	96488	0.3	0.3	948527
2015	260352	379975	314292	93670	7396	101066	0.3	0.2	828820

Figure 1. Geographical distribution of effort (fishing days) of the Galician set-longline fleet operating in non-Spanish Atlantic European waters in 2015. Acronyms of ports: A Coruña (**LGC**), Burela (**BRL**) and Celeiro (**CIO**).

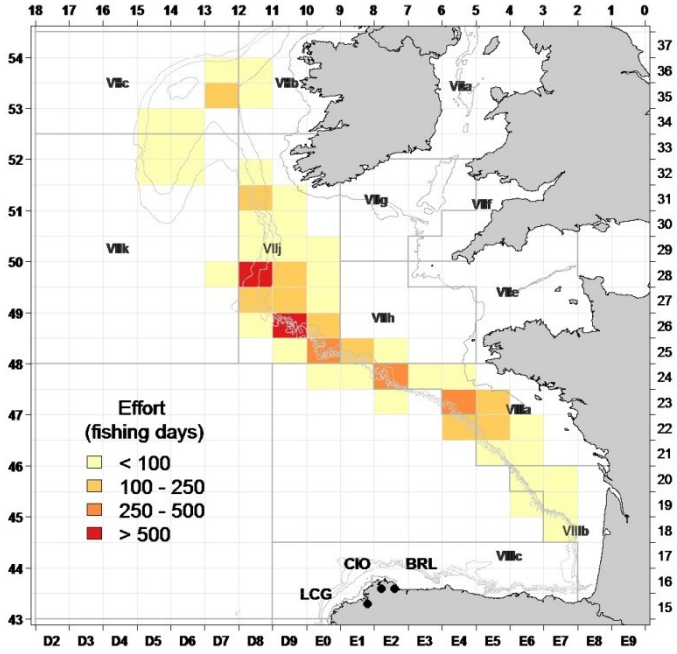

Figure 2. Effort (fishing days) of the Spanish set-longline fleet operating in ICES Subarea VII: by port (Burela, Celeiro and A Coruña). Acronyms of ports: A Coruña (LGC), Burela (BRL) and Celeiro (CIO).

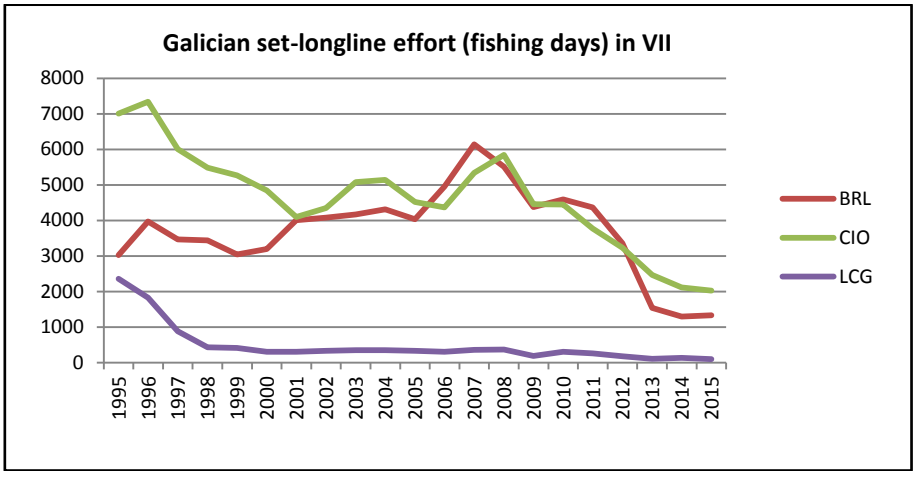

Figure 3. Evolution of the fishing days by trip of the Galician set-longline fleet in ICES Subarea VII.

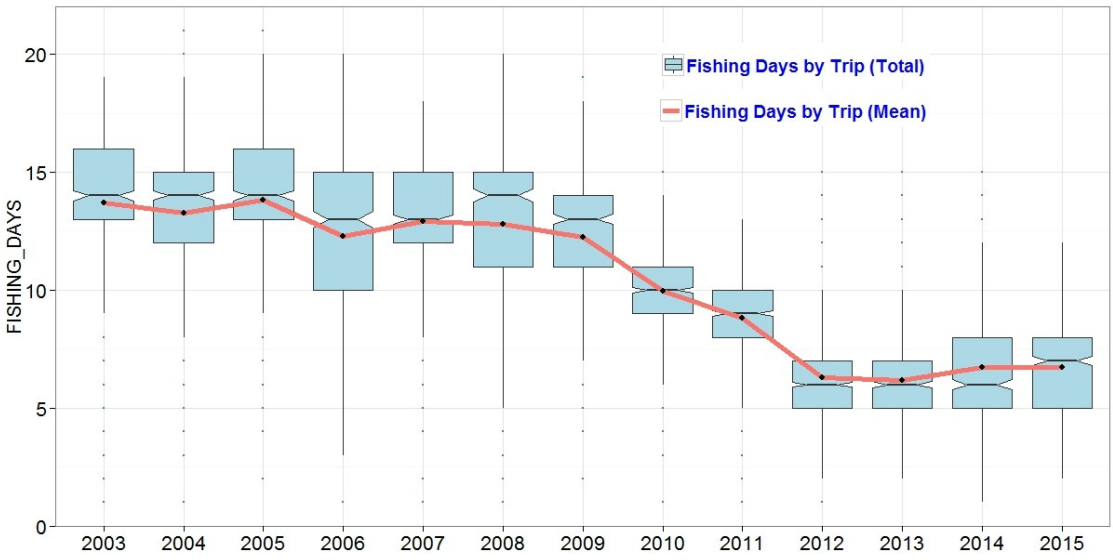

Figure 4. CPUE (tons/fishing day) time series (1995-2015) of hake for the Galician set-longline fleet in ICES Subarea VII.

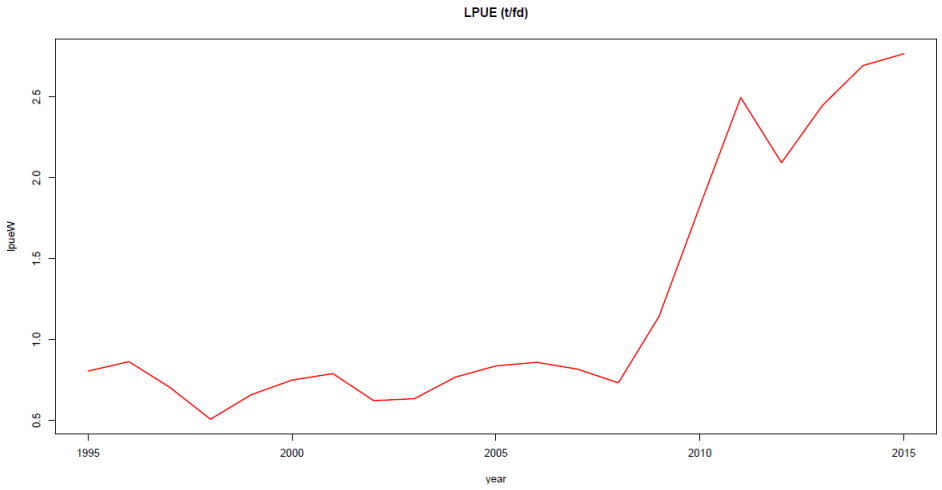

Figure 5. Observed log(abundance indices) and fitted values by quarter of the Galician set-longline CPUE indices in the northern hake assessment (SS3 model).

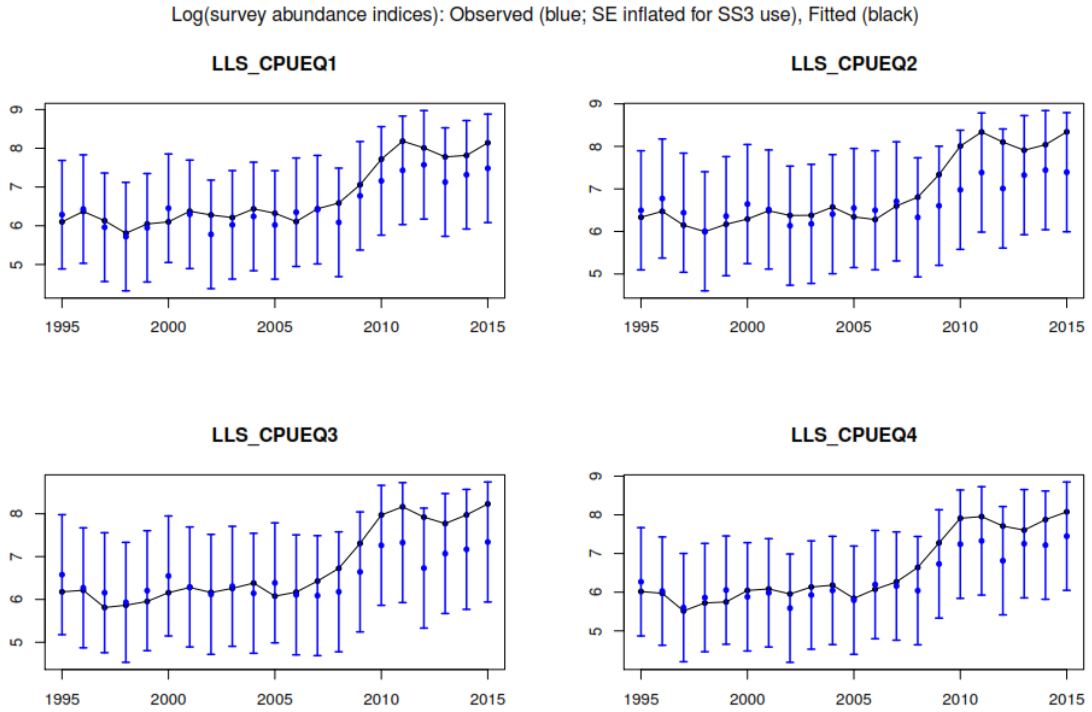

Figure 6. Pearson residuals of the fit to the length distributions of the Galician set-longline CPUE indices, by quarter (SS3 model). Blue and red denote positive and negative residuals, respectively.

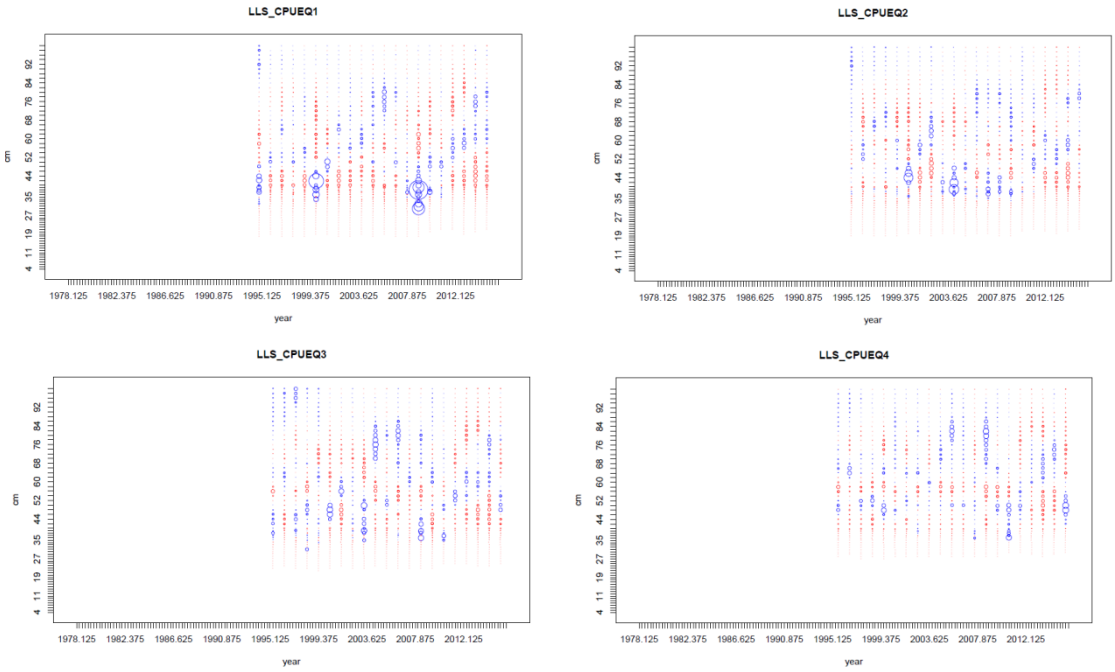

Figure 7. Comparison of assessment results using updated data from 2014 assessment and including the Galician set-longline CPUE indices. Northern hake assessment by applying SS3 model.

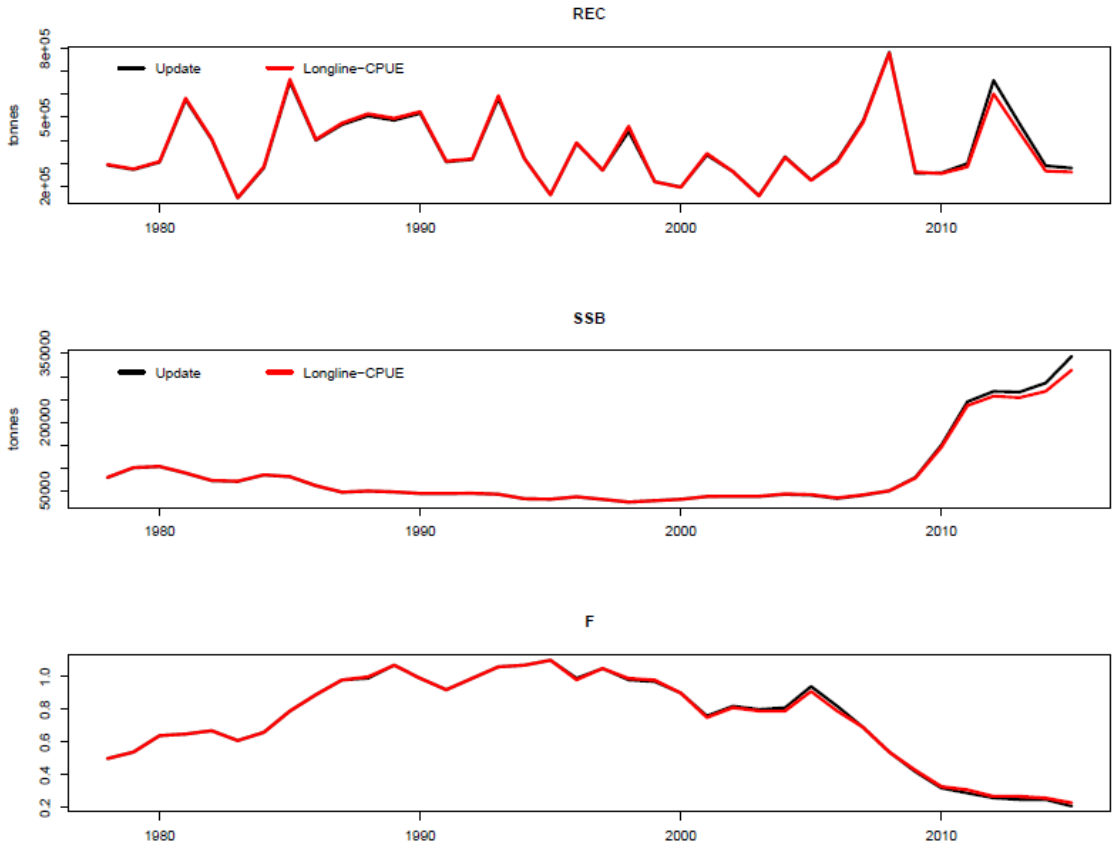

Figure 8. Retrospective plot from SS3: updated run. Northern hake assessment by applying SS3 model.

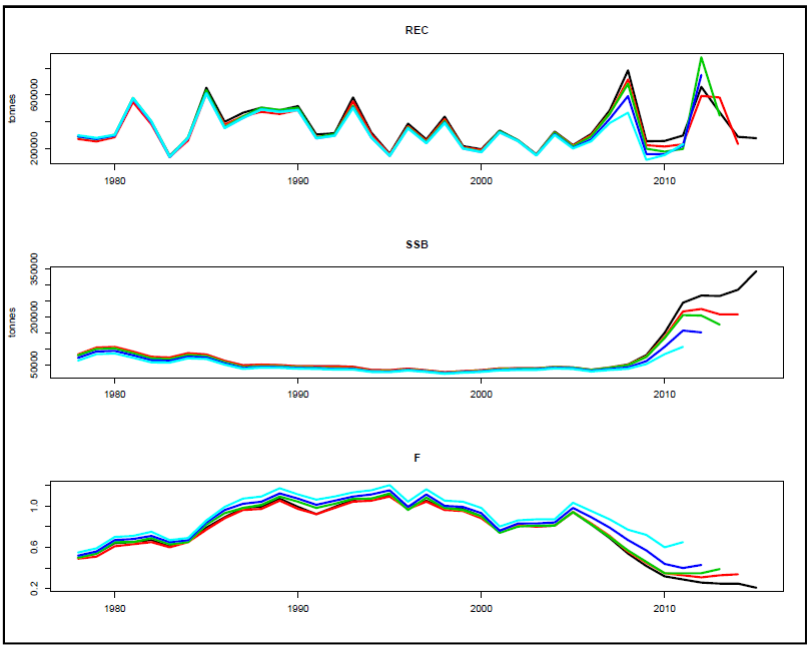

Figure 9. Retrospective plot from SS3: updated run including the Galician set-longline CPUE indices. Northern hake assessment by applying SS3 model.